(19) Europäisches Patentamt
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(11) EP 0 986 124 A2

(12) # EUROPEAN PATENT APPLICATION

(43) Date of publication:
15.03.2000 Bulletin 2000/11

(51) Int. Cl.^{7}: **H01P 1/205**, H01P 1/213

(21) Application number: **99117260.2**

(22) Date of filing: **02.09.1999**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **08.09.1998 JP 25369498**

(71) Applicant:
Murata Manufacturing Co., Ltd.
Nagaokakyo-shi Kyoto-fu 617-8555 (JP)

(72) Inventors:
- **Nishijima, Shohachi,**
  Murata Manufact. Co., Ltd.
  Nagaokakyo-shi, Kyoto-fu 617-8555 (JP)
- **Hiroshima, Motoharu,**
  Murata Manufact. Co., Ltd.
  Nagaokakyo-shi, Kyoto-fu 617-8555 (JP)
- **Kato, Hideyuki,**
  Murata Manufact. Co., Ltd.
  Nagaokakyo-shi, Kyoto-fu 617-8555 (JP)
- **Matsumoto, Haruo,**
  Murata Manufact. Co., Ltd.
  Nagaokakyo-shi, Kyoto-fu 617-8555 (JP)

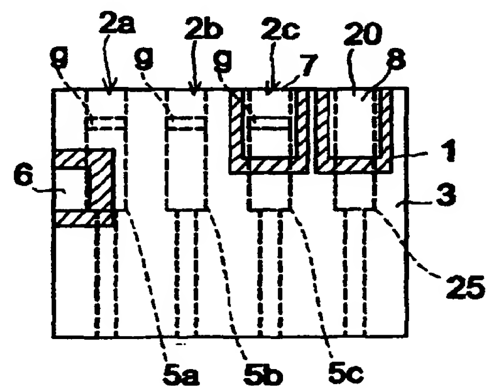
(74) Representative:
Schoppe, Fritz, Dipl.-Ing.
Schoppe, Zimmermann & Stöckeler
Patentanwälte
Postfach 71 08 67
81458 München (DE)

(54) **Dielectric filter, composite dielectric filter, antenna duplexer, and comunication apparatus**

(57) There is provided a dielectric filter, comprising: a plurality of resonance lines (5a - 5c) aligned in a dielectric block (1), in a dielectric substrate, or on a dielectric substrate; a plurality of input-output units respectively coupled to the plurality of resonance lines (5a - 5c); at least one of the input-output units comprising a first external terminal capacitively coupled to one of the plurality of resonance lines, an external coupling line (25) coupled to the one of the plurality of resonance lines to which the first external terminal is capacitively coupled, and a second external terminal (8) extending from an end of the external coupling line (25).

In the above dielectric filter, input and output of signals are performed in a two-terminal type or a balance type, without using a balun.

Fig. 1B



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description of the invention which refers to the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

[0013]

Figs. 1A, 1B, 1C and 1D are projection views of a dielectric filter according to a first preferred embodiment of the present invention.

Fig. 2 is an equivalent circuit diagram of the dielectric filter.

Figs. 3A, 3B, 3C, 3D and 3E are projection views of a dielectric filter according to a second preferred embodiment.

Figs. 4A, 4B, 4C, 4D and 4E are projection views of a dielectric filter according to a third preferred embodiment.

Figs. 5A, 5B, 5C, and 5D and are projection views of a dielectric filter according to a fourth preferred embodiment.

Fig. 6 is an equivalent circuit diagram of the dielectric filter.

Figs. 7A, 7B and 7C are projection views of a dielectric filter according to a fifth preferred embodiment.

Figs. 8A, 8B, 8C and 8D are projection views of a dielectric filter according to a sixth preferred embodiment.

Figs. 9A, 9B and 9C are projection views of a dielectric filter according to a seventh preferred embodiment.

Fig. 10 is a projection view of a dielectric filter according to an eighth preferred embodiment.

Fig. 11 is a block diagram showing a structure of a communication apparatus according to the present invention.

Figs. 12A, 12B, 12C, 12D and 12E are projection views of a prior art dielectric filter.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] Referring to Figs. 1A, 1B, 1C, 1D and 2, a description will be given of a structure of a dielectric filter according to a first preferred embodiment of the present invention.

[0015] Figs. 1A, 1B, 1C and 1D are projection view of the dielectric filter, in which 1A is the upper-surface view, 1B is the front view, 1C is the bottom view, and 1D is the left-side view. The front side shown in this figure is the mounted surface with respect to a circuit board.

[0016] This dielectric filter comprises a rectangular parallelepiped dielectric block 1. In the dielectric block 1, holes and electrodes respectively having specified configurations are provided. The reference numerals 2a, 2b, and 2c indicate resonance-line holes, and on the inner surfaces of the resonance-line holes, resonance lines 5a, 5b, and 5c are respectively provided. An external coupling line hole is indicated by 20, and on the inner surface of the coupling line hole, an external coupling line 25 is provided. The resonance-line holes 2a through 2c and the external coupling line hole 20 are step holes, in which the inner diameters of the upper-half part and the lower-half part are different. Each resonance line has an nonconductive portion indicated by g in the proximity of an end of the large-diameter side of the step hole so as to use this part as an open-circuited end. On an outer surface of the dielectric block 1, an external terminal 8 continuing from one end of the external coupling line 25, external terminals 6 and 7 forming capacitance between these terminals and the resonance lines 5a and 5c, respectively, are provided. Whereas a ground electrode 3 is provided on the substantially entire surface (six faces) except for these external-terminal parts.

[0017] With this arrangement, the resonance lines 5a, 5b, and 5c sequentially make comb-line couplings, and the external terminals 6 and 7 make capacitive couplings (hereinafter referred to as 'C coupling') to the resonance lines 5a and 5c, respectively. Meanwhile, the external coupling line 25 and the resonance line 5c make a comb-line coupling so that output of signals is performed from the external terminal 8 in an inductive coupling (hereinafter referred to as 'L coupling'). The external coupling line 25 does not serve as a resonator for determining the band pass characteristics of the filter, and it is used as an external coupling line. Thus, this dielectric filter serves as a filter circuit in which resonators of three stages are allowed to make the coupling in sequence.

[0018] Fig. 2 is an equivalent circuit diagram of the dielectric filter shown in Fig. 1. In this case, Z1ea and Z1eb are impedance of the resonance line 5a. One resonance line is indicated by two lines on the equivalent circuit, since the resonance line holes are step holes and impedance is different depending on the inner diameter of each step hole. Similarly, Z2ea and Z2eb are impedance of the resonance line 5b, and Z3ea and Z3eb are impedance of the resonance line 5c. Additionally, Z4ea and Z4eb indicate impedance of the external coupling line 25. Cs1, Cs2, and Cs3 indicate capacitance generated at the nonconductive portions g of the resonance lines 5a, 5b, and 5c. In addition, Cs4 indicates a capacitance between the external terminal 8 and the ground electrode 3. Zk_{12o} indicates the characteristic impedance of an odd mode making the comb-line coupling between the resonance lines 5a and 5b, and Zk_{12e} indicates the characteristic impedance of an even mode of the same. Zk_{23o} indicates the characteristic impedance of an odd mode between the resonance lines 5b and 5c, and Zk_{23e} indicates the characteristic impedance of an even mode of the same. Similarly, Zk_{34o} indicates the characteristic impedance of an odd mode between the resonance lines 5c and the external coupling line 25, and Zk_{34e} indicates the characteristic

5e, respectively. 20a, 20b, and 20c indicate external coupling line holes, on the inner surfaces of which are provided external coupling lines 25a, 25b, and 25c, respectively. These resonance-line holes 2a through 2e and these external-coupling line holes 20a, 20b, and 20c are step holes, in which the inner diameter is different in the upper-half part and the lower-half part, respectively, as shown in the figures. On each resonance line, the nonconductive portion indicated by g is disposed near the end on the large inner-diameter side of the step hole so as to use this part as an open end. On an outer surface of the dielectric block 1, the external terminals 8, 6, and 9 respectively continuing from one end of the external-coupling lines 25a, 25b, and 25c, and the external terminal 7 making capacitance between the external terminal and the resonance line 5a, are provided. A ground electrode 10 is provided on the almost entire surface (6 faces) except for these external terminal portions.

[0029] The operation of a duplexer shown in Fig. 7 will be described as follows: First, the resonance lines 5a, 5b, and 5c sequentially make a comb-line coupling, whereas the resonance line 5a and the external terminal 7 make a capacitive coupling. In addition, the resonance line 5a and the external coupling line 25a make a comb-line coupling, whereas the resonance line 5c and the external coupling line 25b make a comb-line coupling. In this arrangement, the external terminals 7 and 8 serve as balance-output terminals, whereby a filter formed of resonators of three stages, which has a band pass characteristic, is formed between the external terminal 6, 7 and 8. Furthermore, the external coupling line 25b, the resonance lines 5d and 5e, and the external coupling line 25c sequentially make a comb-line coupling. This permits a filter formed of two-stage resonators, which has a band pass characteristic, to be formed between the external terminals 6 and 9. In this case, the former filter is used as a reception filter, whereas the latter filter is used as a transmission filter, in which the external terminal 9 is used as an input terminal of transmission signals, external terminals 7 and 8 are used as output terminals of reception signals, and the external terminal 6 is used as an antenna connection terminal.

[0030] A structure of a duplexer according to a sixth preferred embodiment will be illustrated referring to Figs. 8A, 8B, 8C and 8D. In these figures, 8A is the upper-side view, 8B is the front view, 8C is the bottom view, 8D is the back view. The back side in these figures are the mounted surface with respect to the circuit board.

[0031] In these figures, 21a and 21b are dielectric substrates. On the upper surface of the dielectric substrate 21a are provided resonance lines 11a through 11e and external coupling lines 26a, 26b, and 26c, respectively. At specified places on these resonance lines 11a through 11e, electrodeless gaps are provided as open ends. In addition, from the upper surface of the dielectric substrate 21a to the back surface of the same, external terminals 15, 13, and 16, which are extending from the external coupling lines 26a, 26b, and 26c, are respectively provided. A ground electrode 10 is provided on the substantially entire outer surface of the dielectric substrate, except for the area near these external terminals. Furthermore, an external terminal 14 is provided on the back side of the dielectric substrate 21a.

[0032] The operation of the duplexer shown in Figs. 8A through 8D is described as follows: First, the resonance lines 11a, 11b, and 11c sequentially make the comb-line coupling, and the resonance line 11a and the external terminal 14 make the capacitive coupling. In addition, the resonance line 11a and the external coupling line 26a make the comb-line coupling, and the resonance line 11c and the external coupling line 26b make the comb-line coupling. In this arrangement, the external terminals 14 and 15 serve as balance-output terminals, in which a filter formed of resonators of three stages, which has a band pass characteristic, is formed between the external terminals 13, 14, and 15. Furthermore, the external coupling line 26b, the resonance lines 11d and 11e, and the external coupling line 26c sequentially make comb-line couplings. In this arrangement, a filter formed of two resonators, which has a band pass characteristic, is formed between the external terminals 13 and 16. In this case, the former filter is used as a reception filter, and the latter filter is used as a transmission filter. Furthermore, the external terminal 16 is used as an input terminal of transmission signals, the external terminals 14 and 15 are used as output terminals of reception signals, and the external terminal is used as an antenna connection terminal.

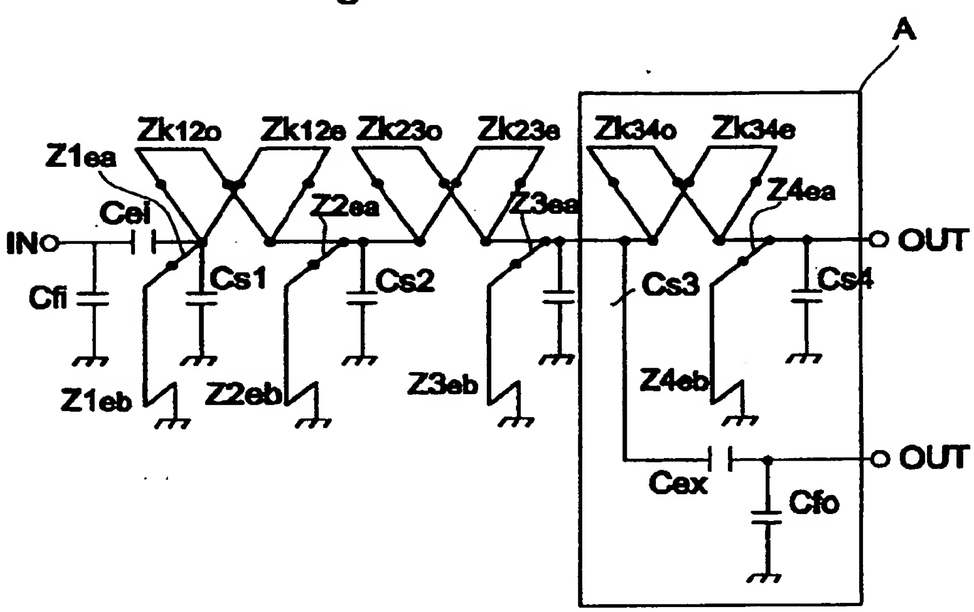
[0033] A structure of a duplexer according to a seventh preferred embodiment will be illustrated referring to Figs. 9A, 9B and 9C, in which 9A is the upper-side view, 9B is the front view, and 9C is the bottom view. In the duplexer shown in this embodiment, which is different from the one shown in Figs. 7A through 7C, one of the balance-output terminals is taken out by the interdigital coupling. That is, the external terminal 8 is disposed on the bottom surface shown in the figure of the dielectric block, and the resonance line 5a and the external coupling line 25a make the interdigital coupling. Additionally, the external coupling line hole 20a is a step hole, in which the inner diameter on the bottom side in the figure of the dielectric block is made to be large. The other arrangements are substantially the same as those shown in Figs. 7A through 7C.

[0034] Next, a structure of the dielectric filter according to an eighth preferred embodiment will be illustrated referring to Fig. 10. In the dielectric filter described above, although the resonance lines are provided inside the dielectric block, inside the dielectric substrate, or on the dielectric substrate, and an nonconductive portion is disposed on a part on the respective resonance lines, the open-circuited ends of the resonance lines may be disposed on an outer surface of the dielectric block or the dielectric substrate.

reception filter provided between the reception signal output terminal (7, 8; 14, 15) and the antenna terminal (6).

5. A communication apparatus, comprising the dielectric filter of Claim 1 or 2, the composite dielectric filter of Claim 3, or the antenna duplexer of Claim 4, each of which being provided in a high-frequency circuit section.

Fig. 2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Zk12e
Zk23o
Zk23e
Zk34o
Zk34e
Z1ea
Cei
Z2ea
Z3ea
Z4ea
IN
OUT
Cfi
Cs1
Cs2
Cs3
Cs4
Z1eb
Z2eb
Z3eb
Z4eb
OUT
Cex
Cfo

Fig. 4A

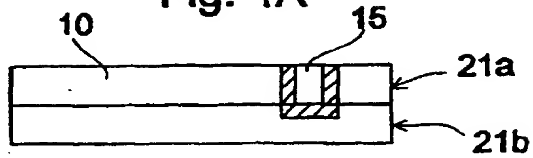


Fig. 4D

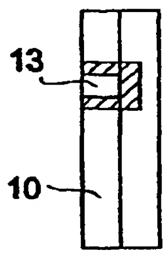


Fig. 4B

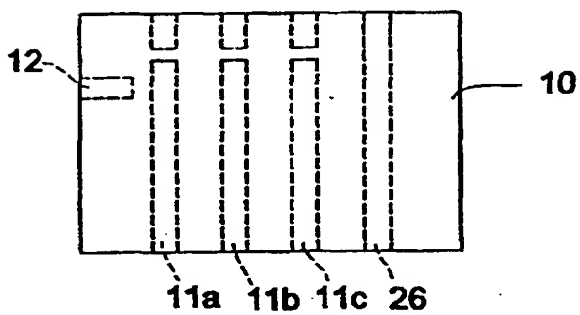


Fig. 4C

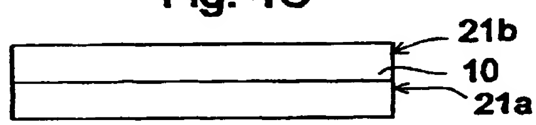


Fig. 4E

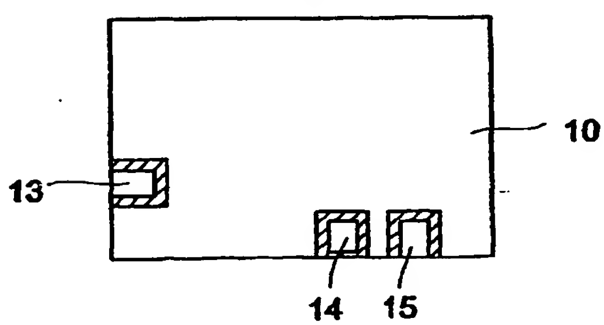
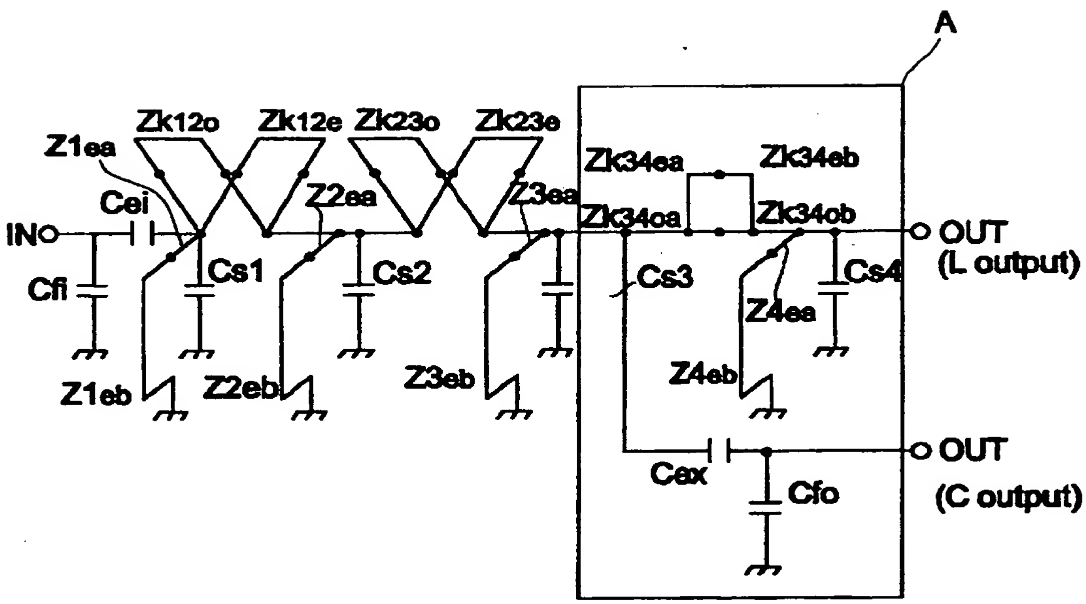


Fig. 6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Zk23o
Zk23e
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Z2ea
Z3ea
Zk34ea
Zk34eb
Zk34oa
Zk34ob
IN
OUT
(L output)
Cfi
Cs1
Cs2
Cs3
Cs4
Z4ea
Z1eb
Z2eb
Z3eb
Z4eb
Cex
Cfo
OUT
(C output)

Fig. 8A

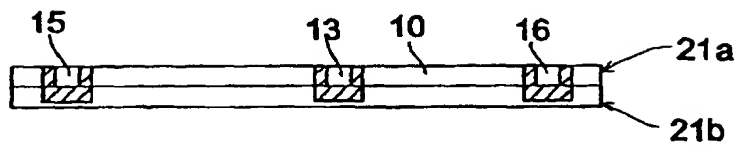


Fig. 8B

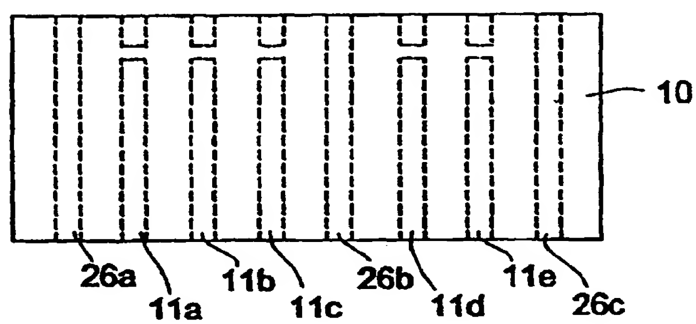


Fig. 8C

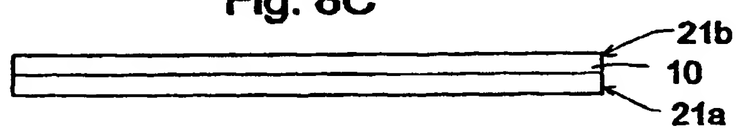


Fig. 8D

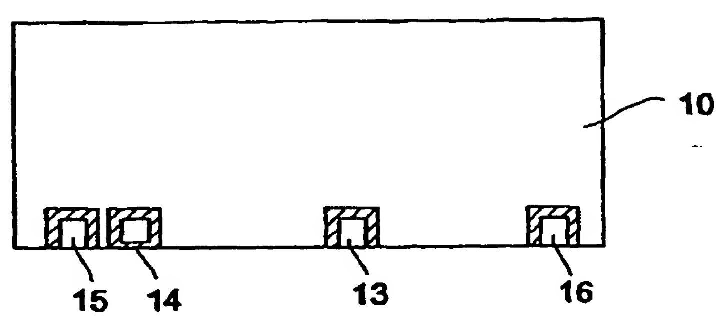


Fig. 10

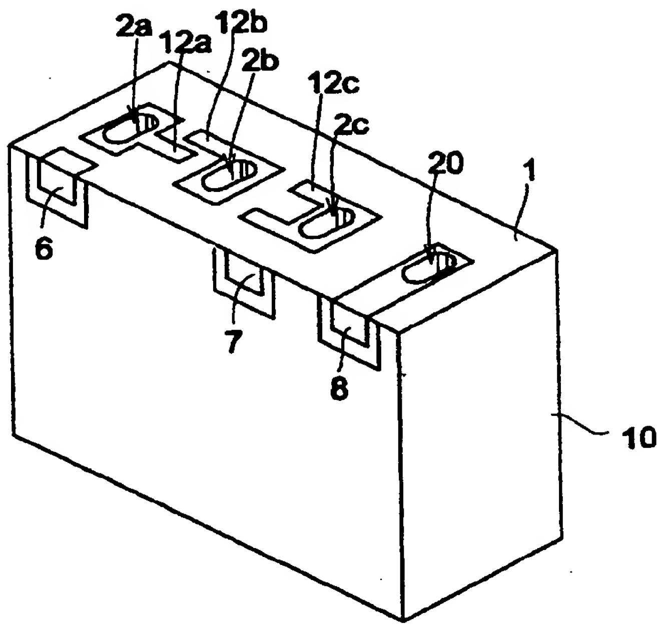
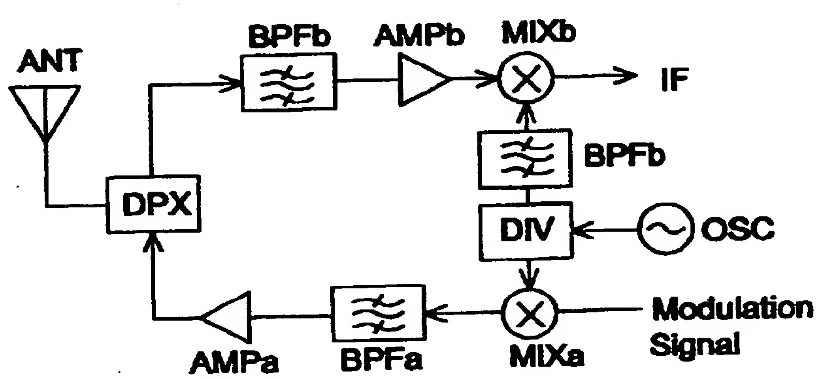

2a
12a
12b
2b
12c
2c
20
1
6
7
8
10

Fig. 11


ANT
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AMPb
MIXb
IF
BPFb
DPX
DIV
OSC
Modulation
Signal
AMPa
BPFa
MIXa

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(11) EP 0 986 124 A3

(12) EUROPEAN PATENT APPLICATION

(88) Date of publication A3:
22.08.2001 Bulletin 2001/34

(51) Int Cl.7: H01P 1/205, H01P 1/213, H01P 1/203

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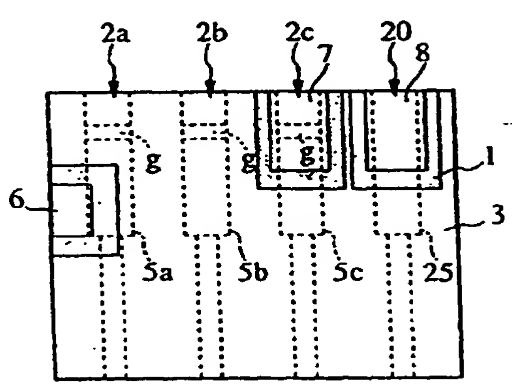
In the above dielectric filter, input and output of signals are performed in a two-terminal type or a balance type, without using a balun.

Fig. 1B



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29-06-2001

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5697088 A	09-12-1997	CN 1173054 A	11-02-1998
		DE 19729761 A	26-03-1998
US 5489882 A	06-02-1996	JP 3117598 B	18-12-2000
		JP 7254807 A	03-10-1995
US 5164690 A	17-11-1992	NONE	
EP 844684 A	27-05-1998	JP 10163715 A	19-06-1998
		US 6040745 A	21-03-2000

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